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LIGAMENTOUS RECONSTRUCTION FOR POST TRAUMATIC CHRONIC INSTABILITY OF DISTAL RADIO ULNAR JOINT (DRUJ)

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CERTIFICATE

This is to certify that the dissertation entitled **"LIGAMENTOUS RECONSTRUCTION FOR POST TRAUMATIC CHRONIC INSTABILITY OF DISTAL RADIO ULNAR JOINT"** is a bonafide record of work done by ***Dr. S. MARIMUTHU*** in the Department of Orthopaedics, Government Rajaji Hospital, Madurai Medical College, Madurai, under the direct guidance of ***DR.T. CHANDRAPRAKASAM M.S.ORTHO., D.ORTHO.,*** & Overall guidance of me.

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CONTENTS

INTRODUCTION

Although our understanding of human anatomy has grown rapidly, the distal radioulnar joint (DRUJ) remains one of the least understood joints in the body. Problems of the DRUJ have been called by Palmer as the **"Low back pain of the wrist"** [15,16]. The disorder of this joint may be due to trauma or arthritis. Injury to this joint may result in pure ligamentous disruption, fractures or both.

Darrach's [7] description in 1912 of a chronic DRUJ dislocation and its treatment with an ulna head resection is one of the earliest reports about the DRUJ. Over the last 15 years, there has been a tremendous surge in research involving the anatomy, function and treatment of DRUJ pathology.

Chronic instability of the distal radio ulnar joint is a relatively common clinical problem. Yet its pathogenesis is complex and often poorly understood. Ligament disruption of this joint result in acute instability which if left untreated leads to chronic instability. Many reconstructive and salvage procedures have been described in an attempt to restore stability.

AIM OF THE STUDY

To analyze the clinical and functional results of Ligamentous reconstruction in cases of post traumatic chronic instability of distal radio ulna joint.

EVOLUTION OF WRIST

Evolution of the wrist[4] began some 400 million years ago with the pectoral fins in a primitive fish known as the Crossospterygia. Several hundred million years later, the primitive amphibian, Eryops, appeared with a pentadactyl extremity, thirteen carpal bones, and a syndesmotic DRUJ. Prono-supination was not present in the Eryops as the ulna was the primary weight-bearing bone of the forearm. From the amphibian to the reptile, the anatomy of the upper extremity remained relatively unchanged.

It was not until mammals first appeared about 230 million years ago that the forearm began to change significantly. With continued internal rotation and pronation of the forearm, the mammal was able to place its extremity in a more efficient position under its body. With the development of bipedalism, hominids developed a mobile wrist, which was important for brachiation, food gathering, self-protection, and care of their young. Complex motion including supination and pronation developed with the evolution of three distinct characteristics

1. Proximal retreat of the ulna so that there was no bony articulation between the ulna and carpus,
2. Development of the triangular fibrocartilage complex (TFCC) and ulnocarpal meniscus,
3. The development of the DRUJ into a synovial joint.

ANATOMY OF DISTAL RADIO ULNAR JOINT

A proper understanding of the complex anatomy of the DRUJ is crucial for the surgeon in order to both properly diagnose and treat patients with chronic DRUJ instability. The DRUJ is part of an interconnected forearm unit. Supination and pronation occur through a complex interaction of bony articulations and soft tissue structures including the radiocapitellar joint, the proximal radioulnar joint (PRUJ), the interosseous membrane (IOM), and the DRUJ.

1. OSTEOLOGY OF THE DISTAL RADIOULNAR JOINT

The DRUJ articulation is trochoid, as is that of the proximal radioulnar joint. The shallow concave sigmoid notch of the distal radius articulates with the convex asymmetric shaped ulna head[10].

SIGMOID NOTCH:

The semi cylindrical, shallow, concave sigmoid articular notch is variable in its depth and angular inclination. (Average 7.7 degrees). Its dimension are on average 1.5 cm dorsovolar and 1 cm proximal distal. The notch has three distinct margins

1. Dorsal margin is acutely angular in cross section.
2. Palmar margin - may be augmented by an osteocartilaginous lip in some individual.
3. Carpal (distal) margin is the junction between the notch and the distally facing lunate facet. The two are separated by the attachment of TFC to the radius.

In a study involving 50 cadaver wrists, Tolat et al[21]. demonstrated 4 main types of notch shapes in the transverse plane: 1) flat (42%), 2) ski-slope (14%), 3) hemicylindric (30%), 4) S-shaped (14%).

HEAD OF ULNA:

The articulation of the sigmoid notch with the ulna head allows rotation of the radio carpal unit in the transverse plane. The head of ulna, or articular seat on which the radius rotates, is an asymmetric semicylinder in shape. The articular surface is inclined a variable amount (averaging 15 to 21 degrees toward the ulna) and has 130 degrees in its dorsopalmar arc.

The medial area of the ulna head has a bony prominence, which is known as the ulnar styloid process. This is the point of attachment for soft tissue structures. The Dorsal nonarticular portion of the ulna head has an osseous groove to accommodate the extensor carpi ulnaris tendon (ECU). Articular cartilage covers a 90 to 135 degree arc of the ulna head, and only a 47 to 80 degree arc on the sigmoid notch.

2. KINEMATICS OF DRUJ

One important geometric joint characteristic of the DRUJ is the radius of curvature between the two articulating surfaces. The radius of curvature of the ulna head (averages 10mm) is different than the radius of the sigmoid notch (averages 15mm). Consequently pronation/supination consists of both the rotational component (transverse plane) and a sliding/translational component (anteroposterior plane) [18].

With the DRUJ in a neutral position and the normal soft tissue support system intact, there exists a 2.8mm dorsal and 5.4mm palmar translation secondary to the differing radii of curvatures. Joint surface contact is maximal at neutral position (60%) and minimal in supination or pronation (10%).

In the frontal plane, the two articular surfaces are usually not parallel as the mean inclination of the sigmoid notch is 7.7 degrees from the longitudinal axis of the radius while the mean articular seat of the ulna head, 21 degrees.

These anatomic characteristics of the DRUJ make the joint inherently unstable. As such, the soft tissue support system around the DRUJ must act as crucial stabilizers.

3. LIGAMENTOUS ANATOMY

The soft tissue support system of the DRUJ can be divided into static and dynamic stabilizers[9].

I. Static Stabilizers :

a. Triangular fibrocartilage
b. Ulno carpal ligaments
c. Interosseous membrane

II. Dynamic Stabilizers :

a. Extensor carpi ulnaris muscle
b. Infratendinous extensor retinaculum
c. Pronator quadratus muscle

I. STATIC STABILIZERS

A. TRIANGULAR FIBROCARTILAGE

The structure attaching the radius to the ulna is variously known as the TFC, carpal articular disc, discus articularis, triangular ligament, triangular cartilage, triangular disc and meniscus. The TFC is part of an extensive fibrous system that arises from the carpal margin of the sigmoid notch of the radius, cups the lunate and triquetral bones, and reaches the volar base of the fifth metacarpal.

Triangular Fibro cartilage is triangular in shape and 1 to 2 mm thick at its base, which is attached to the distal margin of the sigmoid notch. The biconcave body of the structure stretches across the ulna articular dome, and its apex is attached to the eccentric concavity of the head and projecting styloid, where it may be as thick as 5 mm.

The peripheral margins of the triangular cartilage consist of thick lamellar collagen structurally adapted to bear tensile loading. These are often referred to as the dorsal and palmar radioulnar ligamentous margins. The thin central portion, occasionally referred to as the articular disc, is chondroid fibrocartilage, a type of tissue morphologically seen in structures that bear compressive loads. This central area is occasionally absent (congenital perforations) and often so thin as to be translucent.

Compressive force across the carpal-ulnar articulation is partially transmitted through the center of the TFC to the ulnar dome. This same force tends to separate the radius and ulna (particularly in a neutral or negative variant wrist). The TFC results this tendency, thus converting some of the compressive loading to tensile loading within the lamellar collagen of the periphery of the TFC.

The TFC is assisted in meeting this functional demand by the muscular action of the pronator quadratus and the interrosseous membrane. The portion of the compressive load not converted to tensile loading is accepted by the stable and fixed ulna dome.

B. ULNOCARPAL LIGAMENTS

The second major element of the TFCC is the combined volar ulnolunate and ulnotriquetral ligament. These ligaments originate at the base of the styloid, in tandem with the apical attachment of the TFC, and insert volarly on the lunate and triquetrum. Both ligaments pass the TFC as its volar margin.

The general shape of the two ligaments together is triangular, with the apex at the ulna styloid and the base across the lunate and triquetrum, although significant variations in size and shape may occur. As this combined ligament passes the volar margin of the TFC, it is so intimately blended with the TFC that viewed from within the radiocarpal joint, the TFC and ulnocarpal ligaments appear to be a single structure beginning at the radius and cupping the ulnar carpus with intermediate attachment to the ulna styloid.

This anatomic combination supplies the functional demand of suspending the volar ulnar carpus from the dorsoulnar margin of the radius. It resists the volar-ulnar displacement forces generated on the carpus by the flexors in power grip, a displacement well seen in rheumatoid arthritis when progressive destruction of this ligament occurs. The styloid attachment of the complex provides a mechanism for stable, flexible attachment of the radiocarpal unit to the ulna, thereby permitting stable forearm rotations.

TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) :

The combination of the two structures (TFC and ulnocarpal ligaments) is called as Triangular Fibro cartilage complex (TFCC).

Viewed from within the radioulnar joint, the styloid attachment of TFCC appears folded. The folded appearance is actually the confluence of the TFC and V shaped ligament, which extends from the styloid hilar area (its apex) to twin insertions on the volar surface of the lunate and triquetral bones. Between the folds, vessels enter the TFCC. This intraarticular fold and its vascular hilum have been termed the "ligamentum subcruentum" [10,16].

These two structures are morphologically distinct and have individual roles even though the complex functions as a unit. The individual role of the combined ulnocarpal ligaments is to provide a stable connection between the ulna and volar-ulnar carpus. This ligament resists dorsal displacement of the distal ulna relative to the carpus and radiocarpal unit.

The center of this complex (TFC and ulnocarpal ligaments) has been termed the ulnocarpal complex (UCC) by Taleisnik, the TFCC by

Palmer and Werner,[17,23] and the ulnocarpal ligament complex (UCLC) by Campbell.

The TFCC supplies the demands of articulation by

1) Providing a continuous gliding surface across the entire distal face of the two forearm bones for carpal flexion and extension and translational movements,
2) Providing a flexible mechanism for stable rotational movements of the radiocarpal unit around the ulnar axis,
3) Suspending the ulnar carpus from the dorsal ulnar surface of the radius
4) Cushioning the forces transmitted through the ulnocarpal axis and
5) Solidly connecting the ulnar axis to the volar carpus.

D. RADIO-ULNAR INTERROSSEOUS MEMBRANE

Is a static stabilizer that plays an important role in force transmission through the forearm and as a tether between the radius and ulna. The IOM is most taut during supination and prevents diastasis between the radius and ulna. The pronator quadratus muscle attaches distally to both the radius and ulna. It functions as a static stabilizer by maintaining cooptation of the ulnar head in the sigmoid notch passively by its viscoelastic constraints during supination.

II. DYNAMIC STABILIZERS

The dynamic stabilizers of the DRUJ are the extensor carpi ulnaris muscle (ECU) / infratendinous extensor retaniculum and the pronator quadratus muscle. Distally the tendon of the ECU crosses the dorsal ulnar head through an osseous groove and is kept in place by the infratendinous extensor retinaculum.

This system resists dorsal ulna dislocation with full pronation, and palmar ulna displacement with full supination. The pronator quadratus, in addition to functioning as a static stabilizer, also acts as a dynamic stabilizer. With contraction, it actively maintains cooptation of the ulna head in the sigmoid notch during pronation.

STABILITY OF THE DISTAL RADIOULNAR JOINT

The marginal ligaments of the TFC are important, not only in load transference from the carpus to the ulna but also in the stability of the radioulnar joint. The joint is most stable in the extremes of rotation, where the compressive forces between the radius and the ulna are resisted by the reciprocal tensile forces developed within the opposite TFC marginal ligament.

An experimental study of pressure relationships within the joint with rotation shows, the pressure concentrates dorsally in pronation and palmarly in supination. The palmar margin of the TFC is taut in pronation, with this tension developing as the dorsal margin of the radius and the ulna articular surface are compressed. Should the palmar margin of the TFC become attenuated or torn, dorsal subluxation of the distal ulna would occur in pronation relative to the radius.

Similarly, the dorsal margin of the TFC becomes taut in supination while the palmar margin of the sigmoid notch and ulna articular surface are compressed. Should the dorsal margin of the TFC become attenuated or torn, palmar or anterior subluxation may occur.

The integrity of the osseous shape of the convexity of the ulna articular surface and margins of the sigmoid notch obviously play corresponding roles in this rotational stability.

MENISCUS

This element of the ulnar wrist is found in a minority of wrists. When present it lies within the ulnocarpal joint. The meniscus is concave and has a free margin (resembling the meniscus of the knee). When fully developed, the meniscus overlies the TFC-ulnocarpal ligament-styloid complex and extends from the dorsal TFC to the volar ulnar aspect of the triquetrum.

When the meniscus is more developed, it may also contain as ossicle (os lanula, 4 percent), which can be misinterpreted as a styloid fracture. The meniscus, lanula, and prestyloid recess, as well as differences in the length of the styloid are variations in the manifestation of normal ulnar phylogeny.

Arterial Anatomy and Microstructure of the Triangular Fibrocartilage

The vascular supply of the TFCC is via the anterior interosseous artery and the ulnar artery. The anterior interosseous artery divides into palmar and dorsal branches proximal to the DRUJ. The dorsal branch supplies most of the dorsal margin of the TFC. The palmar branch supplies the volar margin near the radius.

Dorsal and palmar branches of the ulnar artery supply the styloid area and the ulnar half of the volar margin of the TFC. Penetration of the terminal branching into the TFC is limited to the outer 15 to 20 percent of the structure, thus leaving the central disc area avascular. The percentage of the peripheral disc that is vascularised is reduced from 33 to 25 percent with aging. In a study, Osterman[14] confirmed the relative paucity of blood flow in the central and radial portions of the TFC in comparison to the periphery.

Chidgey's study reported an avascular random crisscrossing of collagen fibers in the centrum of the TFC (articular disc area) consistent with compressive load bearing. A highly organized, well-vascularized longitudinal collagen arrangement was noted in the peripheral marginal ligaments of the TFC, as well as in its styloid and radial attachments.

PATHOGENESIS OF CHRONIC DRUJ DISORDERS

Chronic instability about the DRUJ can be a challenging problem for the clinician. In order to determine the proper treatment, the specific pathology must be identified. Chronic DRUJ instability can be due to a bony deformity, a ligamentous injury, or a combination of both. The direction of instability of the ulna relative to the radiocarpal unit may be volar, dorsal or both (most commonly dorsal). Acute injuries that are not diagnosed or treated properly can become chronic DRUJ problems.

Instability about the DRUJ is a complex topic, but can be thought of in simplified terms. Stability is normally provided by

1. The somewhat unique articulation between the ulna head and sigmoid notch
2. The alignment and length between the radius and ulna.
3. The Triangular Fibrocartilage complex
4. The adjacent supporting structures such as the ECU, IOM and pronator quadratus.

Stability may be lost with disruption of joint architecture due to fractures / malunions / nonunions of the sigmoid notch, distal radius, ulna head and ulnar styloid process, alteration of the length relationships between the radius or ulna or diaphyseal angulation / rotational malunions of the forearm bones and chronic ligament insufficiency. One of the most common causes of distal radio-ulnar incongruity is a malunion of a prior distal radius fracture.

TFCC INJURY PATTERNS

Palmer and Werner[16,17,23] classified specific TFCC injury patterns. The authors classified TFCC injuries as either traumatic (class 1) or degenerative (class 2). Traumatic TFCC lesions most likely result from a fall on an outstretched upper extremity or from a hypersupination/ pronation of the forearm. Degenerative lesions of the TFCC most likely result from repetitive loading of the TFCC. In addition, it has been shown that the majority of individuals over age 50 have degenerative TFCC lesions. The pathomechanics of rheumatoid arthritis is also an etiology of the degeneration of the TFCC.

Melone et al [13] described TFCC disruption as a spectrum of injury resulting in five stages of increasing severity.

Bowers and Zelouf [5] classified chronic DRUJ disorders by chronic joint disruption due to TFC tears with and without bony malunion involvement; ulnocarpal management; and in arthritic joints.

TFCC ABNORMALITIES

CLASS I – TRAUMATIC

A. Central perforation

B. Medial avulsion (ulnar attachment)

   With distal ulnar fracture

   Without distal ulnar fracture

C. Distal avulsion (carpal attachment)

D. Lateral avulsion (radial attachment)

   With sigmoid notch fracture

   Without sigmoid notch fracture

CLASS II – DEGENERATIVE (ULNOCARPAL IMPACTION SYNDROME)

Stage 1. TFCC wear

Stage 2. TFCC wear

+ Lunate and/or ulnar chondromalacia

Stage 3. TFCC perforation

+ Lunate and/or ulnar chondromalacia

Stage 4. TFCC perforation

+ Lunate and/or ulnar chondromalacia

+ L-T ligament perforation

Stage 5. TFCC perforation

+ Lunate and/or ulnar chondromalacia

+ L-T ligament perforation

+ Ulnocarpal arthritis

Ulnar Variance

According to several studies, the relative lengths of the radius and ulna may differ. This is usually referred to as Hulten's variance.

1. Ulna zero (both the same length)
2. Ulna plus (ulna 1 to 5 mm longer)
3. Ulna minus (1 to 6 mm shorter).

This is apparently an expression of the normal regression of the ulna from its embryonic carpal articulation. Variance is independent of styloid length, which itself may vary.

TECHNIQUE OF ULNAR VARIANCE MEASUREMENT

Ulnar variance may be measured by several techniques. Several studies have indicated that forearm rotation, wrist positioning, grip loading and x-ray techniques may affect the measurement of variance.

The importance of variance may be found in its association with Kienbock's disease and the ulnocarpal loading or impaction syndrome.

Palmer and Werner, Mikie and Uchiyama and Terayama have ably documented the association of a positive ulnar variant with degenerative changes in the ulnolunate articulation and the interposed TFC.

Forearm Rotation

The rotational freedom within the upper extremity of humans may be developmentally related to the period of great apes when arboreal brachiation became important as a means of movement. The hinges of rotation are the distal and proximal radioulnar joints. Kapandji concluded that there are several rotational axes depending on which of the upper extremity bones is fixed. The most common axis used with tridigital grip, passes through the lower radius near the sigmoid notch. The radius rotates about this axis while the ulna translates without rotation.

King et al [11] have noted that clinically measured rotation averages 260 degrees at the hand and 190 degrees at the DRUJ, an average of 4 degrees of hand rotation for 3 degrees of joint motion. From an experimental study they concluded that during rotation, the axis of rotation, which is located near the center of the ulna head, moves in the direction opposite joint motion. The instant center of rotation moves palmarly with supination and dorsally with pronation.

Diagnosis

Disorders of the DRUJ can represent a diagnostic challenge to the clinician not only due to the pathology but also due to the large number of ancillary studies available. A thorough medical history and physical examination of the involved upper extremity are always of importance.

HISTORY

The history should include the

1. Patient's age
2. Hand dominance
3. Occupation
4. Previous injury / problems / surgery

5. Position reproducing pain
6. History of rheumatoid or osteoarthritis
7. Detailed symptom characteristics

With chronic instability, patients may complain of

1. Ulnar sided wrist pain
2. Weakness in grip strength
3. Redness and swelling at the DRUJ
4. “Giving way” or a “clunk” in the wrist
5. Deformity of the dorsal portion of the wrist.

PHYSICAL EXAMINATION

Physical Examination should always include the unaffected side for comparison. Physical examination is begun with an evaluation of both wrists for any gross abnormalities, deformities, swelling or redness. A subluxing ulnar head may be prominent dorsally on the wrist or the caput ulnar syndrome may be present. Active wrist motion usually reveals a limitation in the range of motion secondary to pain or altered biomechanics. The patient is asked to position the wrist to reproduce the pain. At the same time, the examiner should listen for a “clunk”. Grip and pinch strength should be tested bilaterally.

PIANO KEY TEST

The “piano key test” can be performed with the hand pronated and the examiner “balloting” the dorsal ulna head. A positive “piano key test” occurs when there is very little resistance to ballottement and volar movement of the ulna head. In addition, the DRUJ can be “shucked”, to identify joint laxity and crepitus, by holding the radius in one hand and the ulna with the other and moving the distal radius in a volar/dorsal direction.

The ECU tendon/sixth extensor compartment should be palpated and evaluated during resisted pronation to identify any subluxation. Finally, the examination is completed with a sensory, motor and vascular assessment of the entire upper extremity.

Radiographic Evaluation

STANDARD FILMS

A joint that both rotates and moves in space demands a standardized technique for accuracy and comparison follow-up studies. This is increasingly important because radioulnar joint are defined in terms of measurements (variance, carpal height, scapholunate angle, intercarpal distance and so forth) and these measurements are then used for surgical decision-making.

Evans [9] in 1945 published a method for estimating forearm rotation by comparing sequential x-ray projections of the bicipital tuberosity of the radius in progressive degrees of rotation. A similar concept can be applied distally to the ulna. In this technique, we can ascertain forearm rotation by comparing the x-ray projection of the ulnar styloid to that of the shaft of the ulna and to the radius. We can also determine carpal deviation by comparing the position of the lunate with that of the radius.

In the normal configuration of the ulna, the ulnar styloid is posterior (dorsal), just as the olecranon is posterior. The two are in a constant relationship, connected by the subcutaneous ridge of the ulna. The central radius of the articular convexity of the ulnar head is anterior and remains in a fixed relationship to the coronoid process of the ulna. Radius in the zero or midposition of forearm rotation, a lateral wrist film will show the ulnar styloid exactly in the center of the ulna and the radius superimposed on it. An anteroposterior (AP) or posteroanterior (PA) film of this wrist position will show the radial and ulnar styloids farthest apart, at the extreme medial and lateral edges, respectively, of each bone.

In the midposition or zero position of rotation, the ulnar styloid will be directly opposite the radius on PA or AP wrist x-ray. In full pronation, the ulnar styloid will be in the center of the ulnar head on the PA or AP view but volar in relation to the radius on the lateral view. In full supination the ulnar styloid will again be in the center of the ulnar head on the AP or PA view, but dorsal in relation to the radius on the lateral view.

If the shafts of the radius and the ulna are noted to converge proximally on an AP or PA wrist film, this further suggests that the forearm bones are crossed or pronated. When they appear parallel or divergent, the position is either zero rotation or supination. Wrist deviation can be estimated by using the lunate as a landmark. It is a recognized anatomic fact that in neutral or radial deviation the osseous shadow of the lunate on a PA or AP x-ray film is half on and half off the ulnar border of the radius at the DRUJ, and it is completely over the radius (lying in the lunate facet of the distal radiocarpal articulation) if the wrist is in full ulnar deviation.

PATIENT POSITIONING

To obtain Zero rotation ulnar deviation PA view, the patient is positioned with shoulder abducted to 90 degrees, elbow flexed to 90 degrees, forearm in a zero position of rotation and the wrist in ulnar deviation.

To obtain Standard zero rotation – neutral deviation lateral x-ray, the arm is brought to the side (0 degrees shoulder abduction) while the forearm is maintained in zero rotation. Placing the wrist on the cassette brings the wrist into neutral deviation.

The tube-to-cassette distance should be constant and the elbow flexed 90 degrees and the beam direction should, as nearly as possible, be at a right angle to the wrist and centered precisely over the radiocarpal joint. Variations are known to influence the measurement of ulnar variance.

This unique, standard x-ray can be identified by noting the position of the ulnar styloid with reference to the ulna itself and to the radial styloid. Wrist deviation can be appreciated by using the lunate as an internal reference point.

SEMIPRONATED VIEW

The ulnar border of the hand is against the cassette with the forearm and hand pronated 45 degrees. This view helps visualize dorsoulnar structures.

SEMI-SUPINATED VIEW

This view is also sometimes called a “reversed oblique” or “ball catcher” view. It is obtained in a manner similar to the semi-pronated view but with the forearm and hand supinated 30 to 45 degrees. This is useful in evaluation of the volar ulnar quadrant of the wrist especially the pisotriquetral joint and hook of the hamate.

DYNAMIC, PROVOCATIVE OR LOADED VIEWS

Application of compressive forces across the wrist joint loads the radial and ulnar columns and tends to displace an unstable DRUJ. The patient is asked to make a firm fist or more reliably, to squeeze an object such as the standard wrist dynamometer or a roll of cast padding. When compared with the opposite side and nonloaded views, instability may be recognized.

COMPUTED TOMOGRAPHY

The CT scan has proved its clinical usefulness in evaluating both subluxation and dislocation of the DRUJ. Its advantages are that it does not require precise positioning and it can be done through plaster casts, although films of the normal side are recommended. Digital reconstruction is a technique that takes CT data and constructs a picture in any desired plane, not just a cross section.

BONE SCINTIGRAPHY

Radioisotope scans may be very useful in evaluating obscure pain syndromes. Focal uptake may make subsequent (or even previous) films or arthrography more valuable in as much as attention can be directed to these specific areas.

WRIST ARTHROGRAPHY

Wrist arthrography technique adds more precise detail to the collection of diagnostic data, but positive findings do not prove causal relationships to the trauma or condition in question. Recent studies have questioned the relevance of “positive” arthrograms because of,

1) A high incidence of symmetric lesions on both the symptomatic and asymptomatic sides
2) A poor correlation of physical examination and arthrographic findings.

MAGNETIC RESONANCE IMAGING

This method can differentiate soft tissues on the basis of their response to magnetic excitation. Ligament, fat, bone, and fluid can, however, are imaged quite nicely by using the newer, smaller coils specifically designed for the wrist. It is within the scope of this technique to provide noninvasive, no irradiating, real-time images of small joints and their ligaments and fluid contents.

ARTHROSCOPY

Wrist arthroscopy is quickly evolving as the definitive choice for both evaluation and treatment of chronic DRUJ instability. It allows the surgeon to directly visualize the TFCC, the radiocarpal ligaments, and the articular cartilage with a much smaller incision than the open technique.

Osterman [14] reported that with arthroscopic debridement of TFCC tears 73% of 52 patients had full resolution of ulnar wrist pain and an additional 12% had significant improvement of their symptoms. These patients were also reported to have less bleeding, less pain, and a faster return to normal range of motion and strength as compared to patients with an open excision. A lesion seen on diagnostic imaging studies may or may not be symptomatic. To obtain a complete picture, imaging data must always be considered along with the patient history and physical exam.

Operative Exposure of DRUJ

DORSAL APPROACH

The keys to exposure are the ECU and extensor digiti minimi tendons. As it enters the retinacular compartment, the ECU lies on top of the ulnar styloid in any of the positions of forearm rotation. The extensor digiti minimi changes from muscle to tendon as it enters its retinacular compartment. The first centimeter or so of this tendon lies on the radial attachment of the TFC in any position of forearm rotation. The ulna head can invariably be made to pass between these two tendons if the arm is pronated. For exposure of the major portion of the ulnar articular surface, the procedure is begun in full pronation. The incision is begun laterally three fingerbreadths proximal to the styloid along the ulnar shaft and curves gently around the distal side of the head to end dorsally at the midcarpus. For further distal exposure, the incision can be curved back ulnarly. The incision lies just dorsal to the dorsal sensory branch of the ulnar nerve, which must be found and protected from vigorous retraction or pressure during the entire procedure.

As the skin flaps are developed, dorsal veins are retracted rather than cut if possible, and dissection is carried to the obliquely lying extensor retinacular fibers. Beneath the proximal border of the retinaculum, the capsule of the ulnar head passes between the extensor digiti minimi and ECU. The proximal and ulnar half of the extensor retinaculum is reflected radially to uncover the ECU and extensor digiti minimi tendons. The base of this flap is the septum between the extensor digiti minimi and the extensor digitorum communis compartment.

The extensor digiti minimi is retracted to reveal the dorsal margin of the sigmoid notch of the radius and the TFC. The capsule is sharply detached from the radius, with a 1-mm cuff left for later repair. The capsule is then reflected toward the ulna to expose the ulna head for approximately 100 degrees of its total convexity. A small lamina spreader may be used to view the sigmoid notch. For better exposure of the underside of the TFC, the forearm should be brought to midrotation and a nerve hook or small right angle retractor used to expose this area. Magnification is helpful for observing pathologic changes in the TFC.

The retinaculum is divided along the extensor digiti minimi septum; the base of the flap is the attachment of the ECU compartment nearest the ulna. The ECU, where its groove is most pronounced, lies 1 to 2 mm ulna to the attachment of the TFC. The ECU should be fully released only if it is pathologically involved. The unviolated sixth compartment should be subperiosteally dissected from the ulna shaft for exposure without disturbing its stabilizing function. When the extensor digiti minimi and ECU are reflected to either side, one can observe the transverse lying fibers of the dorsal radiotriquetral ligament. This ligament may be incised along its course for a good look at the lunate and triquetral surfaces of the TFC.

For excellent exposure of the styloid, the forearm is carried to full supination with the groove of the ECU used to mark its dorsal base. The reflected capsule may be used as an interpositional arthroplasty flap if fracture comminution or arthritis dictates ulna head extirpation. The ECU should be returned to its styloid groove, and the first retinacular flap can be used to stabilize this location of the tendon if necessary. The intact DRUJ surfaces and ulnocarpal joint structures cannot be fully explored by any single approach because of the intimacy of contact between the radius, ulna and the TFC.

The dorsal approach allows visualization of the dorsal 60 percent of the ulnar head and the carpal face of the TFC, the lunotriquetral ligament, the triquetrum, the meniscus, the prestyloid recess, and most of the DRUJ synovial cavity. If carefully dissected and replaced, none of this exposure should alter joint mechanics or stability.

VOLAR APPROACH

A volar approach allows the remainder of the articular surface to be seen. This approach is indicated for release of soft tissue pronation contracture involving the volar capsular structures.

The FCU and ulnar nerve and artery are retracted ulnarly and the flexor group is retracted radially. A corner of the pronator quadratus is reflected. In a supinated wrist the synovial cavity is easily opened for a look. There may be significant scar tissue here in the post-traumatic wrist. When joint stability is unimpaired, release of this scar may be all that is required for a resistant pronation contracture.

MANAGEMENT OF DRUJ INSTABILITY

An unstable DRUJ without arthritis may be stabilized with the repair of the TFCC and/or with the correction of body malunions. If successful, this anatomic intra-articular reconstruction may restore stability with minimal loss of motion.

If the TFCC is not repairable or the repair is unsuccessful as demonstrated by continued instability, pain, and decreased range of motion, an extra-articular reconstructive approach may be warranted. Although a variety of extra-articular soft tissue reconstructions exist, they are all contraindicated if arthritic changes are present. In addition, bony malunions and length discrepancies must be corrected before or at the time of soft tissue reconstruction.

These general concepts of reconstruction recreate some of the stabilizing elements of the TFCC with tenodesis of the distal ulna using the ECU or flexor carpi ulnaris (FCU) tendon; creating an ulnocarpal tether; and/or creating a radioulnar tether.

TRIANGULAR FIBROCARTILAGE RECONSTRUCTION

For successful soft tissue reconstruction, the essential elements of the TFCC a smooth carpal articulation; A flexible rotational tether, radius to ulna; Suspension of the ulnar carpus to the radius; An ulnocarpal cushion, and ulnar shaft and ulnar carpal connection – must be duplicated in an effective fashion.

I. BUNNELL-BOYES PROCEDURE

The Bunnell-Boyes procedure [10] as a working approach is good, but it does not attempt to provide Elements 1,3 and 4. This technique is, however, innovative and carefully anatomic insofar as reconstruction of DRUJ instability and capacity for rotation are concerned.

The Bunnell-Boyes reconstruction addresses DRUJ instability by re-creating the stabilizing force of the ulnocarpal ligaments. A portion of the FCU insertion is harvested proximally and stripped distally to the insertion on the pisiform. Next the distal portion of the harvested ligament is stabilized by weaving it through the volar capsule to relieve possible torque experienced by the pisotriquetral joint. The proximal portion of the harvested ligament is passed through a drill hole in the ulna close to the styloid and sutured to itself. Finally the repair is completed with imbrications of the dorsal capsule.

II. ADAMS PROCEDURE

Adams procedure[1] (2002) effectively reconstructs the anatomy of both dorsal and palmar radio ulnar ligaments of the TFCC simultaneously.

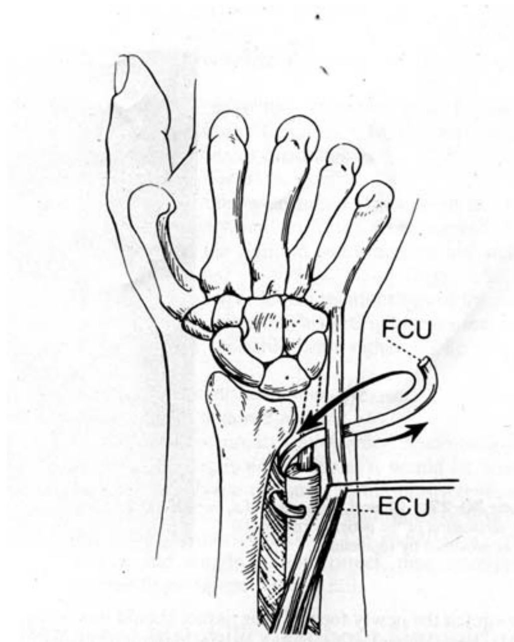
1. Creation of tunnels in the distal radius and ulnar head: -

The radio carpal and radio ulnar joint surfaces are probed with small kirschner wires. A 3.2mm drill hole is made antero posteriorly in the distal radius at the junction of the sigmoid notch and the lunate fossa, as close as possible to the joint surfaces but taking care not to enter either joint. A 2.5mm ulnar drill hole is made in the ulnar head. This passes obliquely from the fovea to the ulnar border of the distal ulna 1.5cm proximally. These holes may be progressively enlarged as necessary to accommodate a tendon graft taking care not to damage the articular cartilage.

2. Reconstruction of the distal radio ulnar ligments

A palmaris longus free tendon graft is harvested by stepladder incision on the volar side. It is first pulled through the tunnel in the distal radius using a wire loop and the tendon is tunneled through the hole in the radius from dorsal to volar side and brought to dorsal wound again. Now both ends of the graft are tunneled through the hole in the distal ulna. Both the dorsal and palmar ends of the tendon graft are then bound around the neck of ulna. The distal radio ulnar joint is reduced and the graft ends are knotted at the ulnar exit hole using a surgeon knot reinforced with 4.0 prolene, and then secured with 4.0 prolene to the ulnar periosteum. This forms a stopper at the entrance of the ulnar tunnel, preventing the graft from sliding in the tunnel and losing the correct tension. The extra length of the graft is looped around the distal ulnar bone and sutured together and to the periosteum. The distal radio ulnar joint is pinned in neutral with 2mm kirshchner wires passed from ulna to radius proximal to this joint, for greater security.

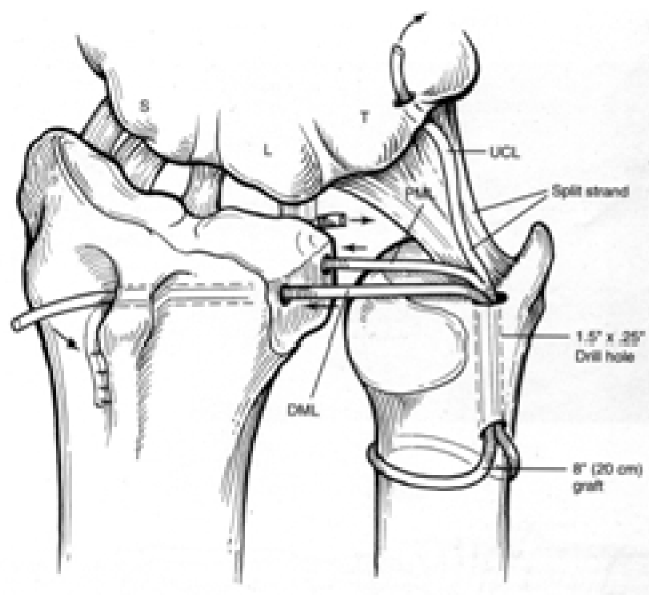
III. TSAI AND STILLWELL TECHNIQUE



Tsai and Stillwell[22] use distally based portions of the FCU harvested proximally and stripped distally to the pisiform attachment. The new “ligament” is stabilized distally by weaving it through the remaining volar capsule. This relieves possible torque stress on the pisotriquetral joint. This new “ligament” is then passed through a drill hole in the styloid area and exits in the axilla of the ulnar articular surface. The repair is completed with imbrications of the dorsal capsule. The techniques are said to be contraindicated in volar dislocations.

The method of Tsai and Stillwell may be used as an adjunct to the Darrach procedure. This aspect of TFCC reconstruction has met with some success. Suspension of the ulnar carpus from the radius (Element 3) and reconstruction of the radius-to-ulnar tether (Element 2) and a cushion (Element 4) have been elusive if the ulnar articular dome is left intact. If some elements are intact, using locally available tissue may selectively augment the missing elements.

IV. GREEN'S TECHNIQUE



A palmaris or plantaris graft (at least 14cm) is harvested and doubled on itself. The two ends are looped around the neck of the ulna and passes distally through an oblique ¼-inch drill hole in the ulna. The hole begins proximally at the neck of the ulnar articular prominence and exits in the fovea at the TFC's normal anatomic attachment site.

The two ends are then used to reinforce or replace deficient portions of the dorsal and/or palmar marginal ligament or ulnocarpal ligaments as required. One of the graft ends may be split if all three elements need reinforcement.

The radial insertion points require both dorsal and palmar approaches. The palmar marginal replacement graft is secured through a drill hole at the palmar corner of the lunate and sigmoid facets and sutured to the adjacent palmar wrist ligaments. The dorsal limb is passed through a drill hole in the radius beginning at the normal attachment of the dorsal marginal ligament and exiting either at Lister's tubercle or in the first dorsal compartment, where it is secured to available soft tissue. The ulnocarpal ligament is attached in a palmar-to-dorsal direction through a triquetral drill hole.

PATIENTS AND METHODS

In our Hand surgery unit, we selected 21 cases of chronic instability of distal radio ulnar joint for this prospective study. Among 21 patients 14 were males and 7 were females. The age group varied from a minimum of 21 years to a maximum of 45 years. The mean age group being 31.3 years.

The duration of the study was from August 2003 to February 2006. The mean follow up was 11.5 months. Dominant hand (Right side) was involved in 6 patients and in 15 patients the non-dominant (left side) was involved. Among 21patients, 10 patients had dorsal instability alone, whereas 11 patients had both dorsal and volar instability.

All patients gave history of injury. Nine patients had initial treatment by plaster immobilization for 10 days to 2 weeks. Two patients had associated Colle's fracture treated by 'K' wire fixation elsewhere. Rest of cases was treated as just sprains elsewhere.

All patients were diagnosed as chronic distal radio ulnar joint instability based on their history, clinical assessment and radiological findings. All presented with ulnar sided wrist pain (or) weakness and were unable to perform their usual occupational duties.

All had mild tenderness on palpation of the distal radio ulnar joint, radial to the ulnar styloid dorsally and palmarly and a positive “Piano Key” sign. On anterioposterior translation in neutral, supination and pronation, 11 patients had increased palmar and dorsal instability of the distal radioulnar joint as compared to the opposite, uninjured wrist. The other 10 patients had dorsal instability only. A prominent ulnar head was noted in 8 patients. Grip strength was diminished in all patients. Supination and pronation were restricted in 6 patients, but all patients had pain at extremes of supination and pronation.

Posteroanterior radiographs in neutral rotation showed widening of the distal radioulnar joint in 8 patients but all patients had some degree of subluxation of the ulnar head compared to the uninjured side on weight bearing lateral radiographs in pronation and supination. Computed tomography, MRI, arthrography and arthroscopy were not utilized.

Selection Criteria

The inclusion criteria for surgery were

1. Patients with ulnar sided wrist pain and inability to perform their usual occupational duties.
2. Patients with clinical evidence of DRUJ instability.
3. Patients who had failed to improve with conservative management consisting of internal splinting and wrist therapy.

EXCLUSION CRITERIA

1. The patients who had radiological evidence of distal radioulnar joint or ulnocarpal osteoarthritis.
2. The patients who had per-operative evidence of erosions in the articular cartilage of the sigmoid notch or ulnar head.

SURGICAL TECHNIQUE

1. Anaesthesia and Positioning of Patients:

The surgery was done in supine position, with the arm placed in hand table. Regional anaesthesia was used in 13 patients and 8 patients were operated under general anaesthesia.

2. Exposure of the Distal Radio ulnar Joint:

For exposure of the major portion of the ulnar surface, the procedure is begun with full pronation. The incision is begun laterally three finger breadths, proximal to the styloid along the ulnar shaft and curves gently around the distal side of the head to end dorsally at the mid carpus. For further distal exposure, the incision can be curved back ulnarly. The dorsal cutaneous branch of ulnar nerve is carefully mobilized and protected from vigorous retraction or pressure during the entire procedure.

As the skin flaps were developed, dorsal veins are retracted rather than cut if possible and dissection is carried to the obliquely lying extensor retinacular fibers. Beneath the proximal border of the retinaculum, the capsule of the ulnar head passes between the Extensor digiti minimi and Extensor Carpi Ulnaris.

The proximal and ulnar half of the extensor retinaculum is reflected radially to uncover the ECU and extensor digiti minimi tendon. The base of this flap is the septum between the extensor digiti minimi and the extensor digitorum communis compartment. The extensor digiti minimi is retracted to reveal the dorsal margin of the sigmoid notch of the radius and the TFC. The capsule is sharply detached form the radius with a 1mm cuff left for later repair. The capsule is then reflected toward the ulna to expose the ulna head for approximately 100 degree of its total convexity. A small lamina spreader may be used to view the sigmoid notch.

For excellent exposure of the styloid the forearm is carried to full supination with the groove of the ECU used to mark its dorsal base.

BUNNELL BOYES PROCEDURE

It includes radio ulnar tether using palmaris longus tendon graft and ulnocarpal tether using one half of flexor carpi ulnaris tendon to reconstruct the volar ulnocarpal ligament.

Tendon Harvesting:

Through separate palmar stab incision, (just above the wrist) 12-15 cm length palmaris longus tendon harvested. This can be split longitudinally into two slips so that it fits into the drill holes and its length is increased. Through the same incision one half of the FCU tendon harvested.

Reconstruction of Distal Radioulnar Ligaments:

A 2.5 mm ulnar drill hole is made in the ulnar head. This passes obliquely from the fovea to the ulnar border of the distal ulna 1.5cm proximally. These holes may be progressively enlarged as necessary to accommodate tendon graft, taking care not to damage the articular cartilage.

The FCU is taken to the dorsum through the volar capsule and in to the distal ulna through a drill hole. The ulnocarpal tether is created by Flexor Carpi Ulnaris tendon.

A drill hole is made Anteroposteriorly, on the ulnar half of the radius just above the sigmoid notch. The Palmaris longus tendon is passed through the hole and wound around the hole in a figure of 8 manners and tied. Thus the radioulnar tether is created by Palmaris longus tendon.

ADAMS PROCEDURE

Adams procedure effectively reconstructs the anatomy of both dorsal and palmar radio ulnar ligaments of the TFCC simultaneously.

1. Creation of tunnels in the distal radius and ulnar head: -

The radio carpal and radio ulnar joint surfaces are probed with small kirschner wires. A 3.2mm drill hole is made antero posteriorly in the distal radius at the junction of the sigmoid notch and the lunate fossa, as close as possible to the joint surfaces but taking care not to enter either joint. A 2.5mm ulnar drill hole is made in the ulnar head. This passes obliquely from the fovea to the ulnar border of the distal ulna 1.5cm proximally. These holes may be progressively enlarged as necessary to accommodate a tendon graft taking care not to damage the articular cartilage.

2. Reconstruction of the distal radio ulnar ligments

A palmaris longus free tendon graft is harvested by stepladder incision on the volar side. It is first pulled through the tunnel in the distal radius using a wire loop and the tendon is tunneled through the hole in the radius from dorsal to volar side and brought to dorsal wound again. Now both ends of the graft are tunneled through the hole in the distal ulna. Both the dorsal and palmar ends of the tendon graft are then bound around the neck of ulna. The distal radio ulnar joint is reduced and the graft ends are knotted at the ulnar exit hole using a surgeon knot reinforced with 4.0 prolene, and then secured with 4.0 prolene to the ulnar periosteum. This forms a stopper at the entrance of the ulnar tunnel, preventing the graft from sliding in the tunnel and losing the correct tension. The extra length of the graft is looped around the distal ulnar bone and sutured together and to the periosteum. The distal radio ulnar joint is pinned in neutral with 2mm kirshchner wires passed from ulna to radius proximal to this joint, for greater security.

Post Operative Rehabilitation: -

The forearm and wrist are immobilized in neutral in an above elbow cast for 6 weeks. The kirschner wires, are removed at the end of this time. The cast is then changed to splint for a further 6 weeks, during which time the patients undergoes active range of forearm supination and pronation exercise at 2 hourly interval. After the 12^{th} week, the patient starts forearm supination and pronation strengthening and passive range of motion exercises.

Patient assessment: -

We used a modified mayo wrist score to evaluate wrist function preoperatively and at follow up. This has previously been used to evaluate wrist function in triangular fibro cartilage complex disorders. (Cooney et al[6]., 1994; Terry and waters 1998). At follow up, in addition to the wrist score we asses distal radio ulnar joint stability.

Stability was assessed clinically looking for the "piano key" sign, dorsal or palmar subluxation of the ulnar head on pronation and supination, laxity on antero posterior translation and pain on compression of the distal radio ulnar joint. Dynamic stability was assessed during active supination and pronation with the elbow flexed to 90^0 while holding a 3kg load. Any sensation of instability was recorded and the distal radio ulnar joint was palpated throughout the range of motion for "clunks" indicating subluxation. Ranges of supination and pronation were assessed with the patients arm adducted to the torso and the elbow flexed to 90 degree.

We used jammar dynamometer for grip strength testing. All patients were tested with the forearm in neutral. The elbow flexed 90^0 and the arm adducted to the torso. For all tests, three readings were taken for each hand, and the average recorded. Results for the reconstructed wrist were expressed as a percentage for the individual's normal grip strength, calculated from the strength of the uninjured side. We considered the normal strength of the dominant hand to be 10% greater than that of the non-dominant hand. Plain postero-anterior and lateral radiographs were taken to assess any widening or degenerative changes of the distal radioulnar joint, bony erosion from friction of the tendon graft, and the integrity of the tunnels. Patients were asked if there were any activities with which they had difficulties, if they had changed occupations because of their wrist symptoms and if they would undergo the same procedure under similar circumstances.

RESULTS

BUNNELL – BOYES PROCEDURE:

There was no intraoperative complication. Post operatively, one patient developed transient parasthesia and altered sensation in the distribution of the dorsal cutaneous branch of the ulnar nerve, but this resolved spontaneously a month after surgery. This was probably caused by retraction of the nerve during surgery.

Out of 11 patients, five patients had excellent wrist score at follow up. Three patients had good wrist score. Pre operatively all patients had either fair (or) poor score, Eight patients improved in all components of the wrist score except range of supination and pronation movements which improved from fair to good rating only. Three cases of dorsovolar instability for which Bunnell–Boyes procedure was done had only marginal improvement (fair grade) post operatively. Out of three patients, 2 patients had recurrence of instability and one had restricted pronation and supination movements. All but two patients were satisfied with the outcome of surgery, and indicated they would undergo the surgery again if necessary. None of the patients had radiological evidence of distal radio ulnar joint widening except for the two patients who developed recurrent instability. The two patients were not willing for any further surgical procedures.

ADAM'S PROCEDURE:-

There was no intra operative complication. Post operatively, one patient had prolonged stiffness following postoperative immobilization for 12 weeks, having failed to return for removal of the cast at 6 weeks. He was lost to follow up after 13 weeks.

Out of 10 patients, 4 patients had excellent wrist scores and 4 patients had good wrist score. All these patients had good stability, pain free good range of pronation and supination movement.

In the two cases of old colle's fracture the patients had pain during extreme range of pronation and supination movements and recurrence of instability of DRUJ during follow up (fair grade). Possible causes of failure in these two patients are insufficient tensioning of the graft and rupture or loosening of the graft during initial mobilization. These patients were not willing for any further surgical procedures.

DISCUSSION

The distal radio ulnar joint is inherently unstable due to shape of its bony architecture and relies mainly on soft tissue supports for its stability. The dorsal and palmar ligments of triangular fibrocartilage complex are the main stabilizers. An anatomical repair (or) reconstruction of these ligaments is the key to restoring distal radio ulnar joint stability.

Since 1930 various ligamentous reconstruction procedures were described. More recently direct reconstruction of radioulnar ligaments are becoming popular but are technically difficult.

Bunnell Boyes procedure has both anatomic and physiological approach. It gives excellent results for dorsal instability, however it is not ideal, when there is both dorsal and volar instability, as evidenced by our study results.

Adam's procedure effectively reconstructs the anatomy of both dorsal and palmar radioulnar ligaments of the TFCC simultaneously. It gives better results, when there is both dorsal and volar instability. However, it is a technically demanding procedure.

In their short term follow up, Adams and Berger[1] (2002) reported that stability was restored in 12 of 14 patients with grip strength improving to 85% normal. Pain was relieved completely in nine patients with five patients having persistant mild pain. Range of Pronation and supination movements improved from 64% to 84% of the normal side. Two patients in their study developed recurrent instability after periods for 1 year and 5 months respectively.

In our study, with Bunnell Boyes procedure stability was restored in 8 of 11 patients, with grip strength improving to 80 % normal. Pain was relieved completely in 8 patients but 3 patients had persistent pain. Range of Pronation and supination movements improved from 58% to 76% of the normal side. Three cases of both dorsal and volar instability had recurrence of instability after Bunnell-Boyes procedure. With Adam's procedure, stability was restored in 8 out of 10 patients, with grip strength improving to 82% normal. Pain was relieved completely in 8 patients but 2 patients had persistent pain. Range of Pronation and supination movements improved from 62% to 80% of the normal side. Two cases of old colle's had restriction of pronation and supination movements.

LIMITATION OF OUR STUDY

1. Small number of cases
2. Short term follow up

CONCLUSION

The goals of chronic instability of DRUJ management are to restore stability and pain free rotation. Ligamentous reconstruction achieves these goals. The Bunnell Boyes procedure is ideal for dorsal instability. The Adam’s procedure gives better results for dorsal and volar instability.

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MODIFIED MAYO WRIST SCORE

I. PAIN

No Pain	25
Mild Occasional Pain	20
Moderate, Tolerable Pain	15
Severe to intolerable Pain	0

II. ACTIVITY

Returned to Regular Activities	25
Regular Activities with Some Restrictions	20
Low Demand Activities	15
Unable to work / play /engage in sports	0

III. RANGE OF MOTION (Supination + Pronation)

$>145^0$	25
130^0-144^0	20
110^0-129^0	15
80^0-109^0	10
40^0-79^0	5
0^0-39^0	0

IV GRIP STRENGTH (Percentage of Normal)

90-100%	25
75-89%	15
50-74%	10
25-49%	5
0-24%	0

FINAL RATING (From Total Point Scored)

Excellent	-	90-100	Points
Good	-	80-89	Points
Fair	-	65-79	Points
Poor	-	< 65.	Points

PROFORMA

1) Name: **Age:** **Sex:**

2) Address:

3) IP No: **DOA:** **DOS:** **DOD:**

Side of Injury: **Right/Left**

Dominant Side: **Right/Left**

4) Mode of Injury:

5) Associated injuries:

6) INVESTIGATION:

Plain X-ray wrist AP and Lateral views.

Loaded view wrist AP and lateral views.

Blood HP/Urea/Sugar/Grouping and typing

Chest X-ray

ECG

Initial Management:

Plaster immobilization

Surgical management

No treatment

7) SURGERY:

General Anaesthesia / Regional Anaesthesia

Patient Positioning

Interval between injury and surgery

Type of Instability

Bunnell - Boyes / Adams Procedure.

8) COMPLICATIONS:

Per operative complication

Immediate Post Operative complication

Complication noted at follow up

9) PRE OPERATIVE MAYO WRIST SCORE:

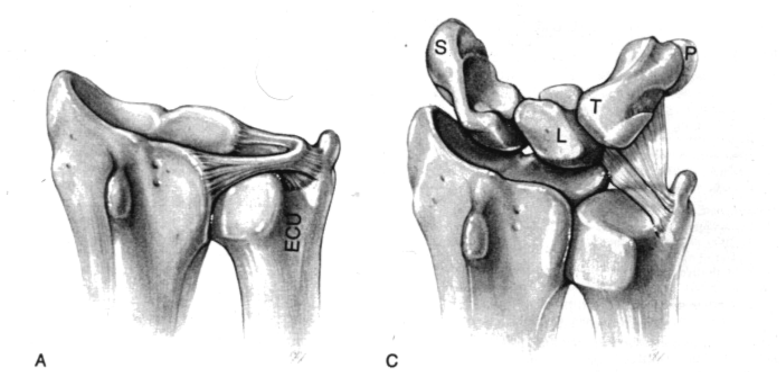
10) FOLLOW UP MAYO WRIST SCORE:

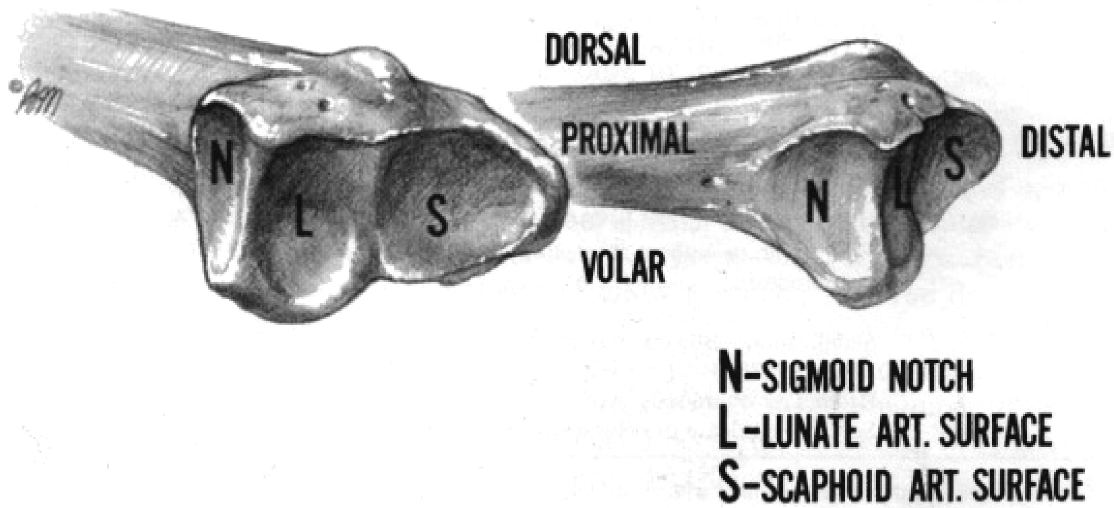
11) GRADE:

DISTAL RADIO ULNAR JOINT

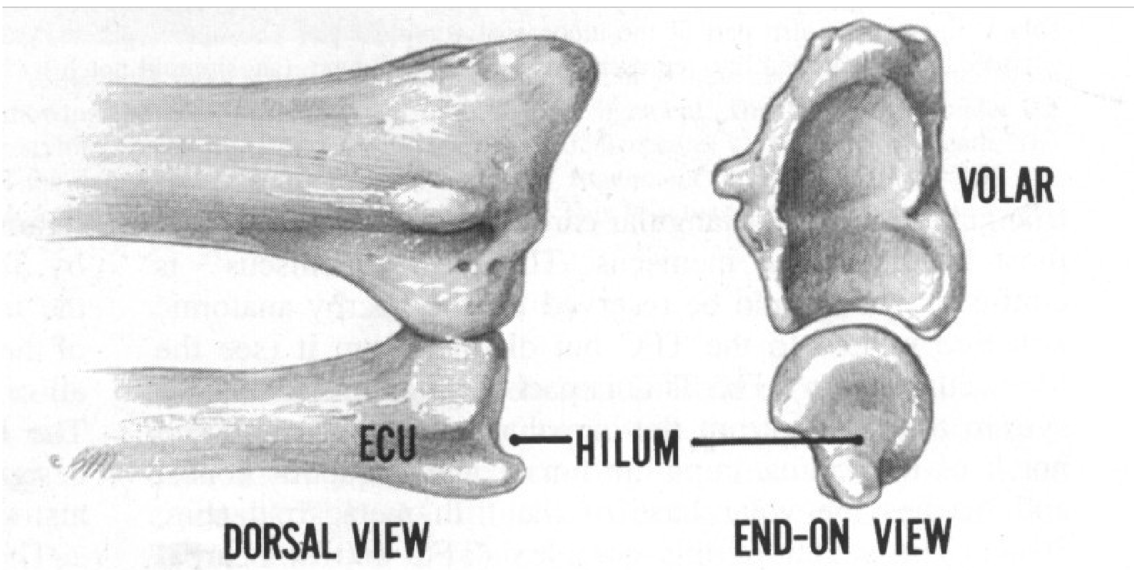
TRIANGULAR FIBRO CARTILAGENOUS COMPLEX

TFCC & Ulnocarpal Ligament

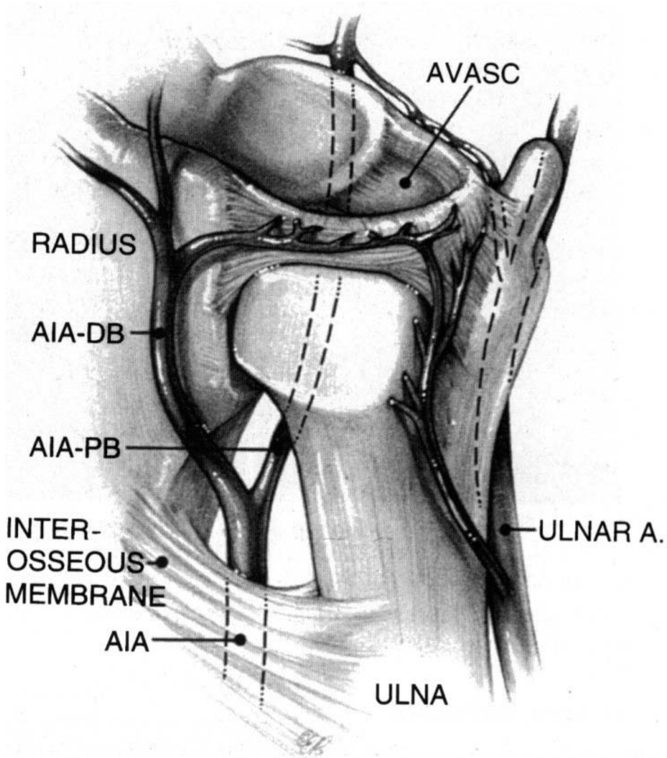




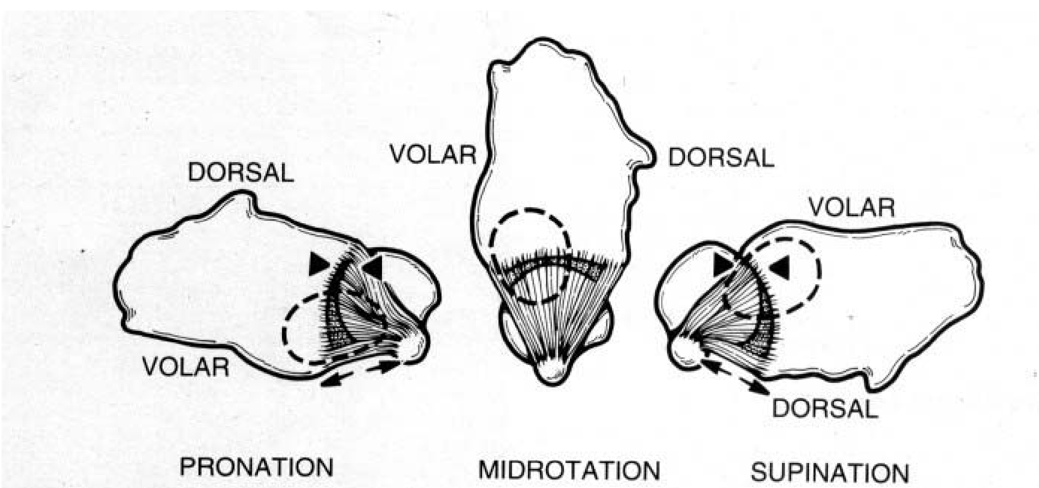
OSTEOLOGY OF THE DISTAL RADIOULNAR JOINT



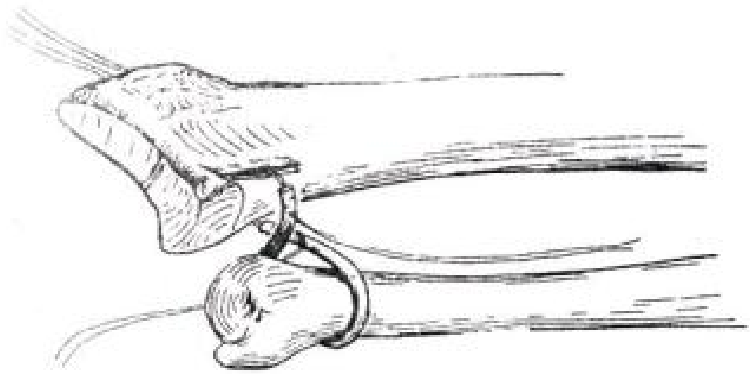
ARTERIAL ANATOMY OF TFCC



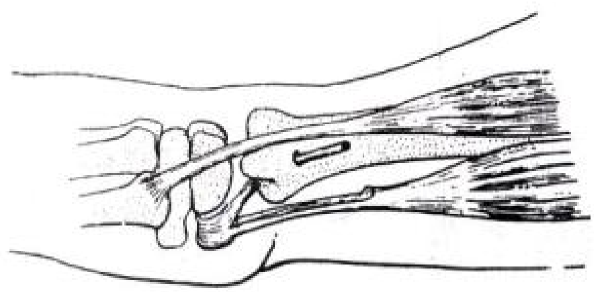
STABILITY OF THE DISTAL RADIOULNAR JOINT



BUNNELL – BOYES PROCEDURE



Radio ulnar tethering by palmaris longus tendon graft

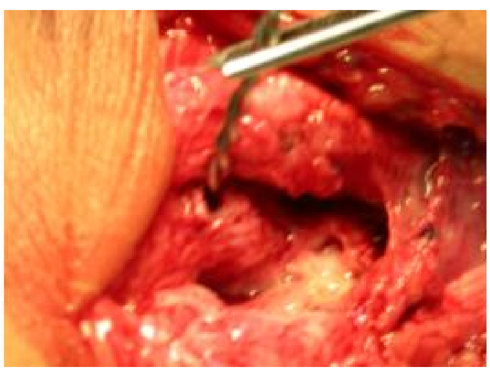


volar ulno carpal ligament reconstruction by one half of FCU

ADAM'S PROCEDURE

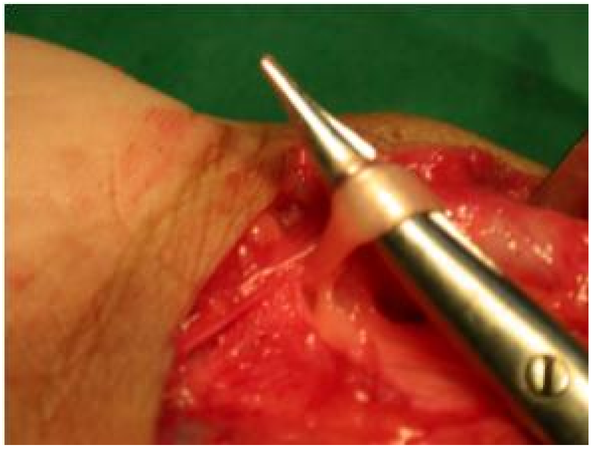
SKIN INCISION

DRUJ EXPOSED

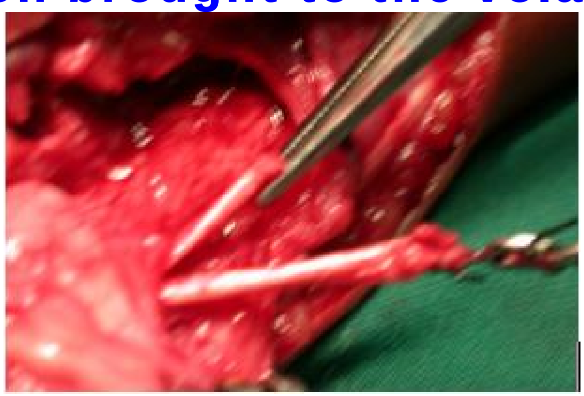


Drill hole through distal radius

ADAM'S PROCEDURE

Error!

PL tendon brought to the volar wound



Both Limbs Of PL Tendon Brought Through Ulnar Hole

Tied Securely Around Neckof Ulna

Bunnell – Boyes Procedure- case I


pre Operative Pictures Showing DRUJ Instability


x-ray Showing Dorsal Instability


Post Operative Pictures Showing Good Stability At The End Of 6 Months

Bunnell – Boyes Procedure- case II

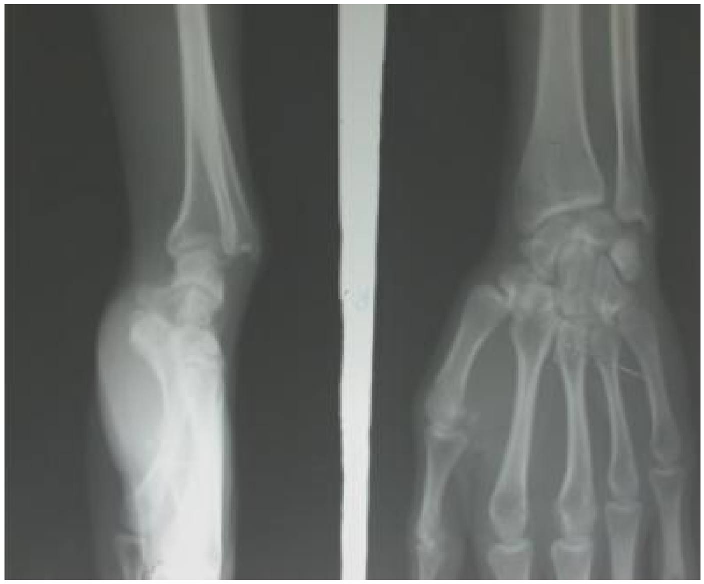
Pre operative Photo / X-ray Showing Dorsal Instability

Post Operative X-Rays Showing Good Head Notch Releationship

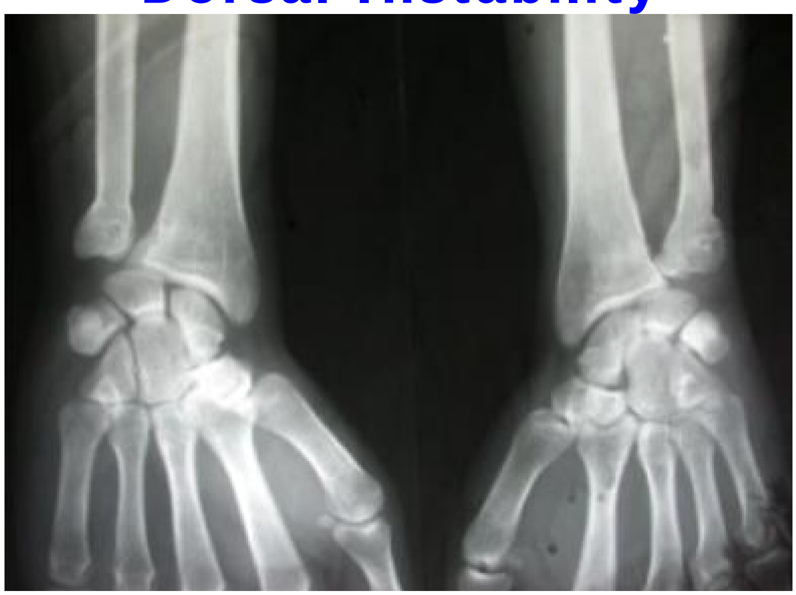
 

Clinical Pictures Showing Good Stability At 16 Months Follow Up

Bunnell – Boyes Procedure- case III



Pre operative X-rays Showing Dorsal Instability



Post Operative X-rays Showing Good Head Notch Relationship At 17 Months Follow Up

Adam's Procedure case – I


Pre operative Photo / X-ray Showing
Dorsovolar instability

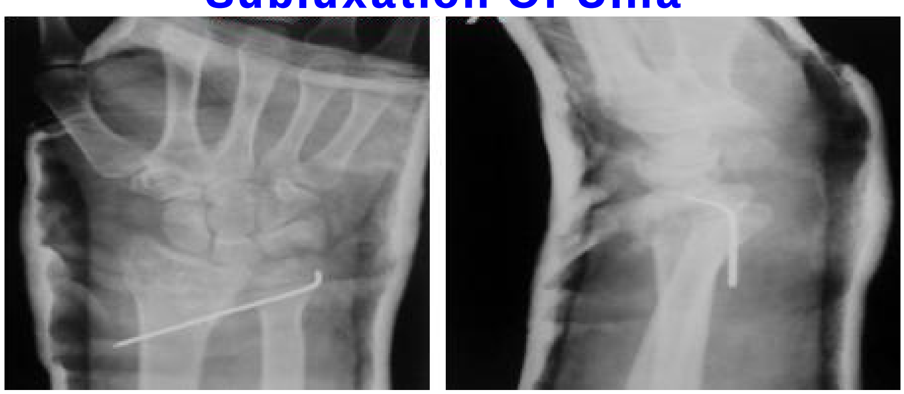
Immediate Post Operative Pictures
DRUJ Stabilized with Kirschner Wire


Good Stability At The End Of 6 Months

Adam's Procedure case – II

Colles Fracture Initially Treated With Multiple K-Wires

At The End Of 3months Patients Had Subluxation Of Ulna



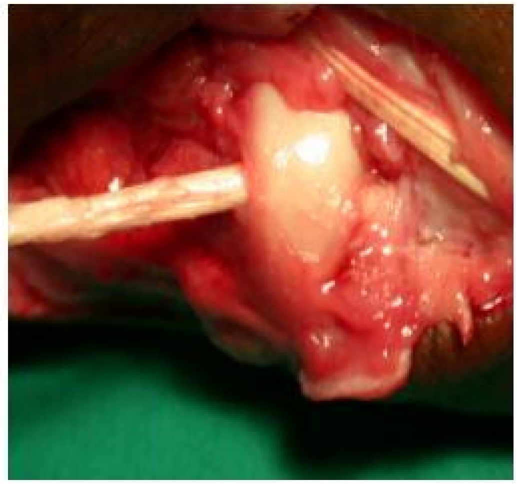
Post Operative X-Ray After K Wire Stabilization Of DRUJ

BUNNELL – BOYES PROCEDURE

SKIN INCISIONS DRUJ EXPOSURE

PALLMARIS LONGUS TENDON AND
ONE HALF OF FCU HARVESTED

BUNNELL – BOYES PROCEDURE

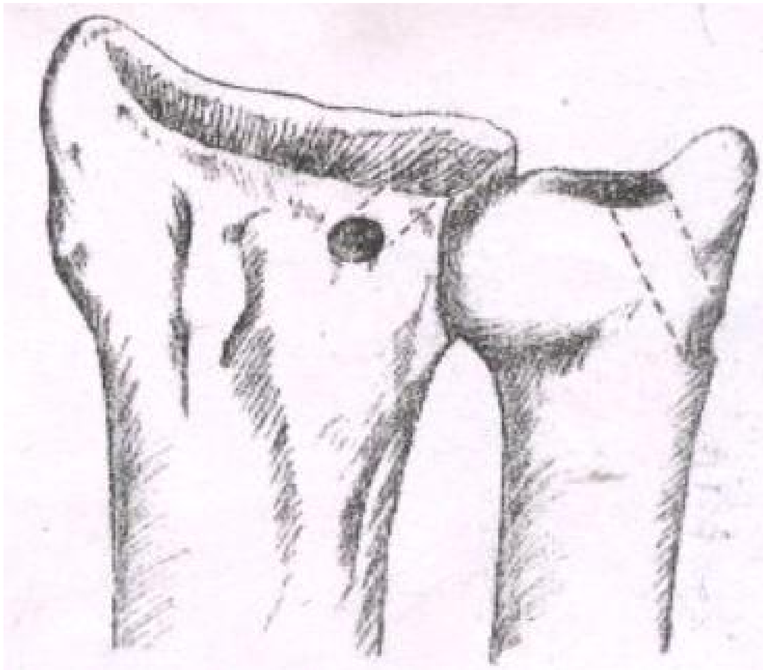


FCU to the dorsum AND passing through a drill hole in the distal ulna

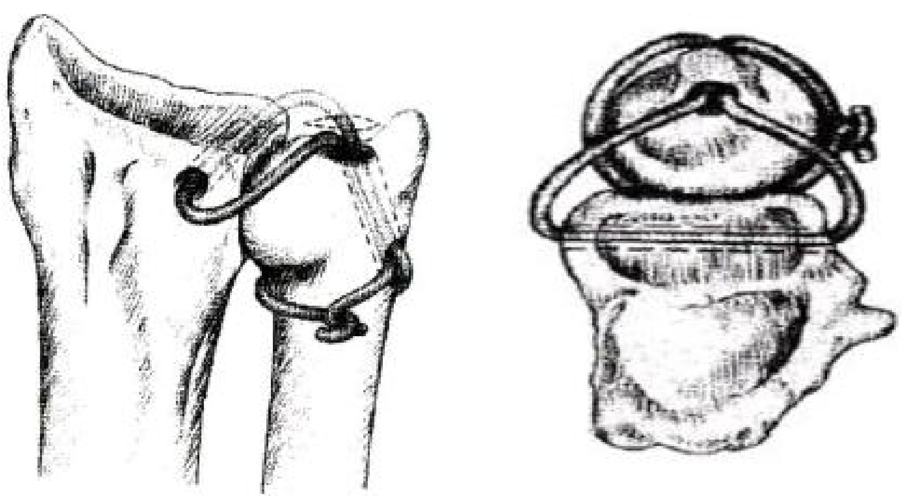
Ulno Carpal Tether Created By Palmaris Longus Tendon

Radio Ulnar Tether Created By One Half Of FCU

ADAM'S PROCEDURE



LOCATION OF RADIUS AND ULNA TUNNEL



Reconstruction Anotamy Of Both Dorsal And Palmar Radio Ulnar Ligements Of TFCC

TABLE 1 AGE

Age group	Bunnell's Boyes procedure		Adam's procedure	
	No	**%**	**No**	**%**
20-24	2	18.2	2	20
25-29	3	27.2	2	20
30-34	2	18.2	3	30
35-39	2	18.2	2	20
40 & above	2	18.2	1	10
Total	11	100	10	100
Mean	31.7.years		31.3 years	
S.D.	6.8 years		6.4 years	
X^2	0.0199			
p	0.8877			

There is no significant difference in the mean age of the patients under going the two types of procedure.

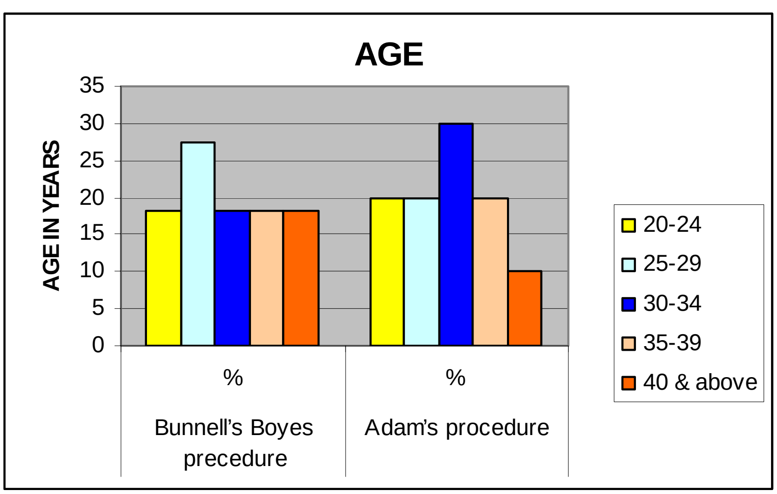


TABLE 2 SEX

Sex	Bunnell's Boyes precedure		Adam's procedure	
	No	**%**	**No**	**%**
Male	9	81.8	7	70
Female	2	18.2	3	30

$X^2 = 0.01$

P = 0.4502

The sex composition of the two groups of patients does not differ significantly

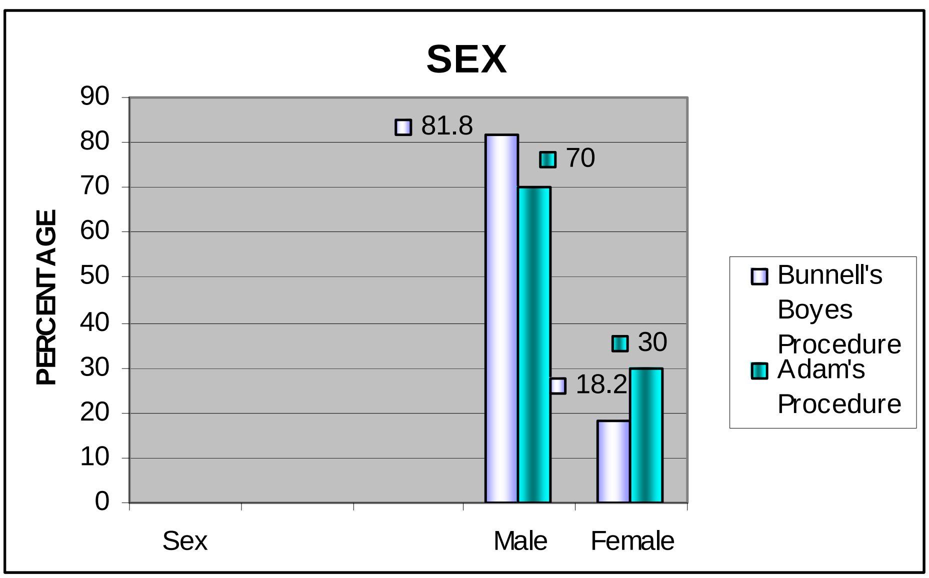


TABLE 3 SIDE

Side	Bunnell's Boyes precedure		Adam's procedure	
	No	**%**	**No**	**%**
Left	8	72.7	7	70
Right	3	27.3	3	30

$X^2 = 0.12$ P =0.6327 No Significant difference

TABLE 4 INSTABILITY

Instability	Bunnell's Boyes precedure		Adam's procedure	
	No	**%**	**No**	**%**
Dorsal	8	72.7	2	20
Dorsal +velar	3	27.3	8	80

$X^2 = 3.92$ P= 0.0226

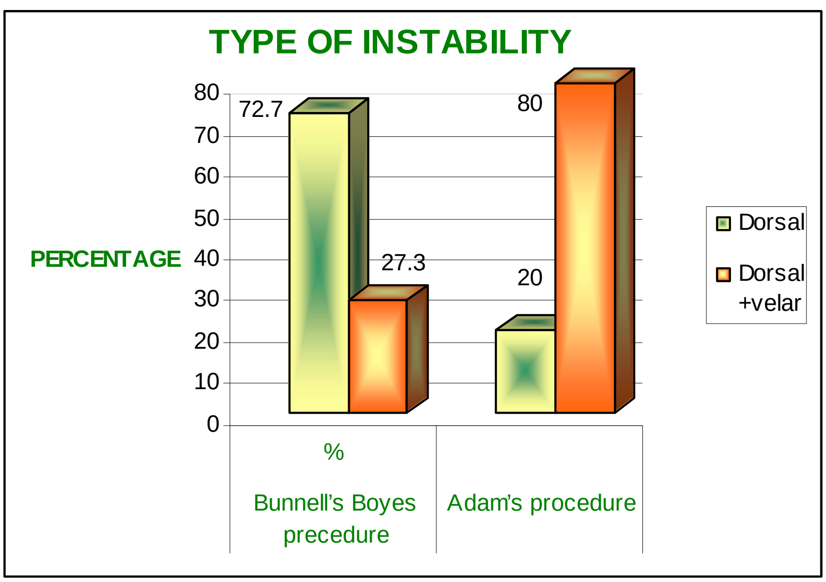


TABLE 5 INTERVAL BETWEEN INJURY AND SURGERY (IN WEEKS)

Interval in weeks	Bunnell's Boyes precedure		Adam's procedure	
	No	**%**	**No**	**%**
20-24	2	18.2	2	20
25-28	3	27.3	3	30
29-32	4	36.3	1	10
33-36	2	18.2	3	30
37-40	-	-	1	10
Total	11		10	100
Mean	28.5 weeks		29.7 weeks	
S.D.	4.2		5.1	
X^2	0.2467			
P	0.6194			

The mean internal between injury and surgery does not different significantly between the two groups.

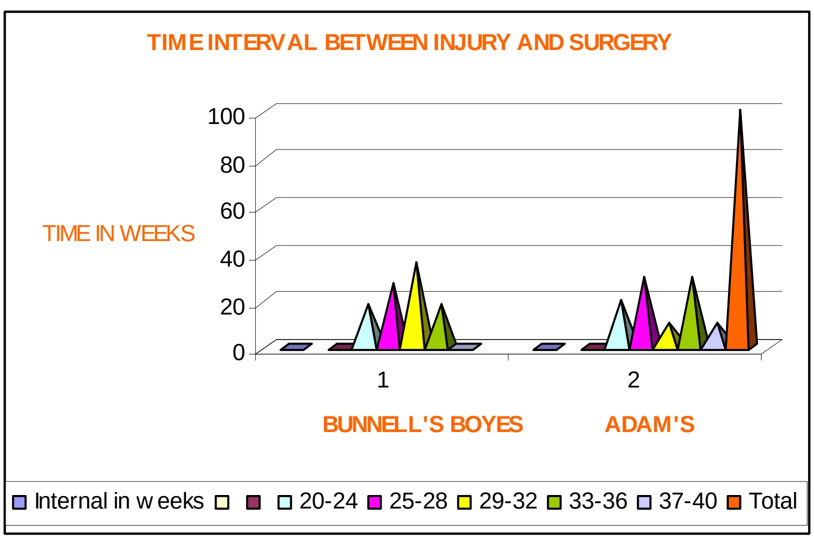


TABLE 6 MAYO WRIST SCORES

Mayo wrist score	Pre operation Mayo wrist score		Follow up Mayo wrist score	
	Bunnell	**Adam**	**Bunnell**	**Adam**
Mean	64.1	62	85.9	86.0
S.D.	5.8	3.5	8.0	8.8
X^2	1.4269		0.0052	
P	0.2323		0.9424	

There is no significant difference in the preoperative and follow up Mayo wrist scores in the two procedure.

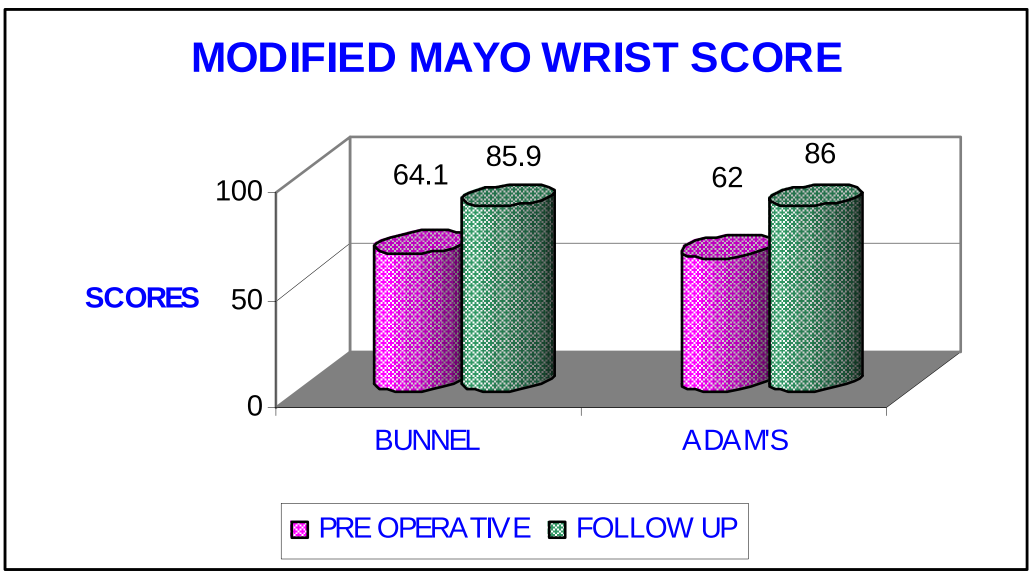


TABLE 7 STABILITY

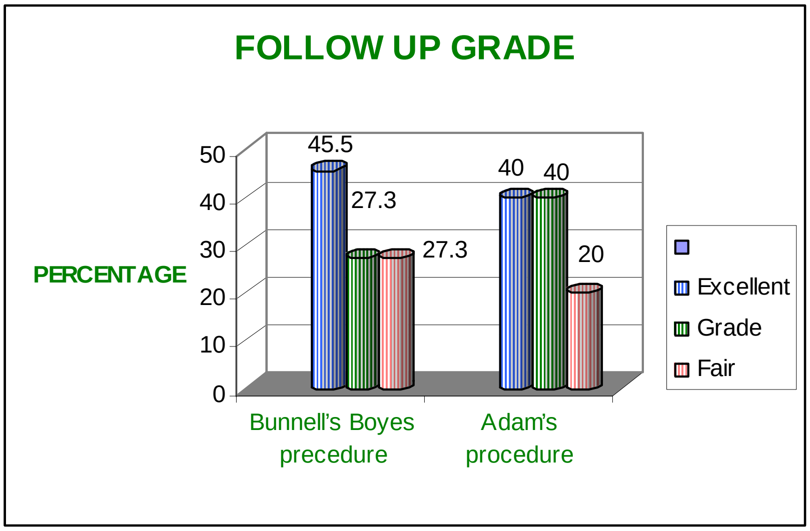
Stability	Bunnell's Boyes precedure		Adam's procedure	
	No	**%**	**No**	**%**
Stable	9	81.8	9	90
Unstable	2	18.2	1	10

$X^2 = 0.01$ P= 0.5376 Not significant

TABLE 8 GRADE

Grade	Bunnell's Boyes precedure		Adam's procedure	
	No	**%**	**No**	**%**
Excellent	5	45.5	4	40
Grade	3	27.3	4	40
Fair	3	27.3	2	20
Poor	-	-	-	-

$X^2 = 0.01$ P= 0.5498 No Significant difference.



Sl. No	Patient Name	Age	Sex	I.P.No	Side	Instability	Interval between injury and surgery	Followup (months)	Pre Operative Mayo wrist score	Follow up mayo wrist score	complication	Stability of DRUJ in active load bearing	Grade
BUNNELL BOYES													
1	Paulsamy	29	M	345222	Rt	Dorsal	26	9	60	90	Nil	Stable	Excellent
2	Kandan	24	M	324567	Lt	Dorsal + Volar	22	12.5	65	75	Recurrence	Unstable	Fair
3	Chellamuthu	42	M	328624	Lt	Dorsal	30	11	65	85	Nil	Stable	Good
4	Manohar	27	M	319684	Lt	Dorsal	22	16	70	95	Nil	Stable	Excellent
5	Sivakami	38	F	338276	Rt	Dorsal	26	13	75	95	Nil	Stable	Excellent
6	Kavitha	22	F	320674	Lt	Dorsal	34	14	65	85	Nil	Stable	Good
7	Mariappan	32	M	312874	Lt	Dorsal	32	17	65	85	Nil	Stable	Good
8	Shanmugapriya	25	F	334260	Lt	Dorsal	30	14	65	95	Nil	Stable	Excellent
9	Krishnappan	40	M	316891	Rt	Dorsal + Volar	28	10	55	75	Recurrence	Unstable	Fair
10	Velusamy	34	M	331246	Lt	Dorsal	34	13	65	90	Nil	Stable	Excellent
11	Mahenderan	36	M	332678	Lt	Dorsal + Volar	30	14	55	75	Restricted Romactivity	Stable	Fair
ADAM'S PROCEDURE													
12	Selva Kumar	36	M	345967	Lt	Dorsalvolar	24	14	60	85	Nil	stable	Good
13	Muthuselvi	27	F	331765	Lt	Dorsalvolar	26	9	65	95	-	stable	Excellent
14	Devikala	23	F	342672	Rt	Dorsalvolar	37	10	60	85	-	stable	Good
15	Sivasankar	29	M	321266	Lt	Dorsalvolar	36	13	60	70	Restriction of SUP/PRO movements	stable	Fair
16	Murugan	42	M	318671	Lt	Dorsal	22	14	60	90	-	stable	Excellent
17	Kaliappan	30	M	322668	Rt	Dorsalvolar	28	10.5	65	95	-	stable	Excellent
18	Shanthi	22	F	314672	Lt	Dorsalvolar	30	2	60	75	Recurrence	Unstable	Fair
19	Thirupathi	32	M	309672	Lt	Dorsalvolar	33	13	70	95	-	stable	Excellent
20	Asokhan	34	M	327613	Lt	Dorsalvolar	27	9	60	80	-	stable	Good
21	Nallamuthu	38	M	321726	Rt	Dorsal	34	11	60	90	-	stable	Good